Remote-Site Ambient Ozone Data Summary, 2019

Regions 2 and 4, US Forest Service

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Dark Canyon (Gooseberry Guard Station) remote ozone monitoring site, Manti-LaSal National Forest, Utah

Executive Summary:

- Decreased wildfire activity in the Pacific coast states and across Regions 2 and 4 resulted in considerably lower ozone impacts in 2019 compared to the previous year. Ozone peaked in late spring at most high-elevation sites, with mid-summer peaks occurring at many lower-elevation sites.
- The Uintah Valley of northeastern Utah and sites proximate to the Wasatch Front and Front Range urban areas continued to be subject to potentially hazardous levels of surface ozone. All of these sites are located in areas already identified as nonattainment areas by USEPA. Design values at six sites in these areas exceed the ozone NAAQS for the period of 2017-2019.
- The monitoring site in the Bear's Ears National Monument was heavily impacted by nearby wildfires.
- The Great Basin continues to be an area of contrast, with the network's most-impacted site (Snowbird, near Salt Lake City) and least-impacted (Great Basin NP and Ruby Guard Station, both in eastern Nevada).

I. Changes in the Regulatory Environment

Legal challenges to, and review of, the current (2015) EPA ozone NAAQS continued in 2019 (following information from Federal Register 2020). In a case before the District of Columbia Circuit Court, *Murray Energy Corp.* v. *EPA,* "[I]ndustry and state petitioners argued that the revised standards were too stringent, while the environmental and health petitioners argued that the revised standards were not stringent enough to protect public health and welfare as the Act requires. On August 23, 2019, the court issued an opinion that denied all the petitions for review with respect to the 2015 primary [human health] standard while also concluding that the EPA had not provided a sufficient rationale for aspects of its decision on the 2015 secondary [vegetation impact] standard and remanding that standard to the EPA."

Other arguments in the case were presented for and against the use of the W126 statistic for enforcing the secondary ozone NAAQS: "The EPA's decision not to use a seasonal W126 index as the form and averaging time of the secondary standard was also challenged, but the court did not reach that issue, concluding that it lacked a basis to assess the EPA's rationale on this point because the EPA had not yet fully explained its focus on a 3-year average W126 in its consideration of the standard." The issue of using W126 as a metric for a secondary standard was remanded to the EPA for further analysis.

After EPA's review of recent research on ozone's impact on vegetation, "the Administrator judged that such a standard with a level of 70 ppb would provide the requisite protection from adverse effects to public welfare by limiting cumulative seasonal exposures to 17 ppm-hrs or lower, in terms of a 3-year W126 index, in nearly all instances." In other words, the EPA elected to retain the current 70-ppb 4^{th}-maximum as both primary and secondary standards. Public comment on this decision is ongoing and expected to continue through most of 2020.
RMRS now has a sufficient baseline of data to calculate long-term W126 trends, if that metric is designated for secondary standard assessment.

II. Network Performance, Changes and Updates for 2019

Monitoring at the Silt-Collbran and Flattops sites was discontinued at the end of 2018. CDPHE did not request additional data from the Manitou Experimental Forest site for 2019, so the site was not operated. No new sites were established.

RMRS and NFS workers maintained a total of 19 sites. Data from all non-USFS maintained sites included in the 2018 report are again summarized this year.

Network-wide, data completeness was 80.3%, and 78.3% at USFS-managed sites. This is a significant drop from the past several years. Although equipment malfunctions contributed to data loss, operator availability and difficulties with scheduling resulted in a delayed start to data collection at some high-elevation sites.

RMRS replaced old, ineffective nafion tubes in the sample path of nearly all analyzers before deployment in 2019. Analyzer performance in CDPHE on-site audits was greatly improved this year. Of ten sites audited, nine were within acceptable performance limits. The exception was Sunlight, which was equipped with an older instrument. This instrument was replaced in late 2019, and no further problems of this nature are expected.

Power-supply problems continued to plague the Ruby Guard site in northeastern Nevada. All of the equipment at this site was removed at the end of 2019 and taken back to RMRS. Subsequent examination of the equipment by RMRS and Campbell Scientific failed to yield a definitive problem, and new equipment was prepared for deployment in 2020.

The SJNF-maintained Shamrock Mine was inactive for most of the first half of 2019 due to a lapse in funding.

A series of instrument malfunctions and power supply problems resulted in significant data loss at Briggsdale, unfortunately during the late spring period when ozone levels are often highest. The site's batteries and instrumentation were replaced.

Sizable wildfires (Peavine Canyon and Poison Canyon) burned in close proximity to Dark Canyon (Bear's Ears National Monument, Manti-La Sal NF; see appendix for details) in early August, resulting in the compromise of about one week of data.

The instrument enclosure at Kremmling was damaged when the wind blew it off its mount in the BLM office's equipment yard, resulting in about one month of lost data. The enclosure was re-attached and re-started in early August.

Power supply problems (persistent icing of the solar panels) resulted in the loss of some wintertime data at Little Mountain (northeastern Utah). Operators converted the site to line power in March, which has permanently mitigated the problem.

Fig. 1. RMRS ambient ozone data collection locations on and near R2/R4 forests, 2019.

Year-Round Sites	Forest	Begin Date	End Date	Data Completeness	Notes
Pawnee Buttes	PNG	1 Jan	31 Dec	86.4	
Briggsdale	PNG	1 Jan	31 Dec	78.5	Power supply problems
Kenosha Pass	PSINF	1 Jan	31 Dec	86.1	
Sunlight Mtn	WRNF	1 Jan	31 Dec	81.7	
Little Mtn	Ashley	1 Jan	31 Dec	80.3	Icing, power supply problems
Centennial CASTNet	MBRNF	1 Jan	31 Dec	93.5	
RMNP CASTNet	RMNP	1 Jan	31 Dec	98.4	
Gothic CASTNet	GMUG	1 Jan	31 Dec	95.5	
GBNP CASTNet	GBNP	1 Jan	31 Dec	98.8	
Mesa Verde CASTNet	MVNP	1 Jan	31 Dec	97.0	
Shamrock	SJNF	1 Jan	31 Dec	56.3	
Seasonal Sites					
Deadman Pass	ARNF	18 Jul	9 Oct	58.8	Late deployment
Goliath Pk	ARNF	10 Jul	2 Oct	66.0	Late deployment
Trout Cr Pass	PSINF	1 May	2 Oct	93.1	
Kremmling	BLM	6 May	15 Oct	71.0	Wind damage
McClure Pass	GMUG	6 May	6 Oct	93.5	
Ripple Cr Pass	WRNF	12 Jul	16 Oct	65.2	Late deployment
Grand Mesa	GMUG	12 Jul	6 Oct	51.7	Late deployment
Norwood	SJNF	29 Mar	3 Oct	95.9	
Douglas Pass	BLM	29 Mar	6 Oct	94.7	
Snowbird	WCNF	27 Mar	5 Oct	98.6	
Dark Canyon	MLSNF	11 Jul	4 Oct	52.5	Late deployment
Ruby Guard	HTNF	4 May	25 Sep	30.6	Power supply problems

Table 1. 2018 Network performance

II. Data Summary:

	Average O_3 (ppb)		Daily 8-hour O_3 (ppb)				Cumulative O_3 (ppm-hr)	
Year-Round Sites	**Daytime**	**Overnight**	**Max**	**Date**	**4th Max**	**Date**	**Max W126****	**Period**
Pawnee Buttes	45.2	38.9	71.9	6 Aug	66.7	3 Aug	11.1	Jun-Aug
Briggsdale	41.1	24.8	79.6	6 Aug	72.8	23 Jul	13.7	Jul-Sep
Kenosha Pass	51.7	48.0	71.7	23 May	69.2	16 Apr	16.1	Apr-Jun
Sunlight Mtn	49.3	48.7	72.8	16 Apr	69.9	22 May	14.0	Apr-Jun
Little Mtn	51.7	51.7	74.6	23 May	71.6	1 Jun	14.6	May-Jul
Shamrock*	43.5	37.3	62.6	6 Sep	59.6	5 Sep	6.2	Jul-Sep
Centennial CASTNet	48.3	47.9	67.8	23 May	65.0	23 Apr	10.1	Apr-Jun
RMNP CASTNet	47.3	43.3	67.0	25 Mar	65.6	1 Jun	9.5	Mar-May
Gothic CASTNet	48.2	41.8	71.4	22 May	66.4	16 May	12.7	Mar-May
GBNP CASTNet	45.2	43.3	71.4	3 Jul	66.5	27 Jun	10.0	May-Jul
Mesa Verde CASTNet*	47.8	45.3	69.5	9 Jun	65.1	25 Jun	10.5	Apr-Jun
Dinosaur CASTNet	44.3	32.2	80.4	28 Feb	70.8	26 Feb	9.6	Feb-Apr
Seasonal Sites								
Deadman Pass*	51.3	49.5	66.0	26 Aug	63.6	10 Sep	--	--
Goliath Pk*	53.6	53.4	78.3	19 Jul	69.7	28 Aug	11.3	Jul-Sep
Trout Cr Pass	52.5	47.0	73.6	22 May	65.9	6 May	13.4	May-Jul
Kremmling*	46.1	23.6	64.1	5 Jun	60.8	1 Jun	--	--
McClure Pass	49.8	48.4	71.4	23 May	67.2	25 May	10.0	May-Jul
Ripple Cr Pass*	41.9	41.3	58.8	21 Aug	55.4	19 Jul	2.6	Jul-Sep
Grand Mesa*	52.2	51.6	70.9	9 Sep	65.5	24 Sep	9.2	Jul-Sep
Norwood	48.7	36.7	65.9	22 May	63.2	19 May	9.2	Apr-Jun
Douglas Pass	48.2	48.6	64.4	13 Apr	63.4	4 Jun	7.6	Apr-Jun
Snowbird	53.3	51.3	74.0	27 Aug	69.3	4 Jun	15.3	Jun-Aug
Dark Canyon***	49.7	48.1	60.2	25 Aug	57.5	5 Sep	7.8	Jul-Sep
Ruby Guard*	48.4	46.4	63.2	3 Jun	60.4	26 Jun	--	--

Table 2: Summary statistics for all 2019 Sites. "Average O_3" is the mean of ozone readings between 8 a.m.-8 p.m. (Daytime) and 8 p.m.-8 a.m. (Overnight) for the entire growing season (April-September). "Daily 8-hour O_3" reports the days on which the highest and 4th-highest 8-hour averages were recorded (see text for further explanation). Values in red (over 70 ppb) are contributory to NAAQS exceedance.

*indicates site where missing data precluded complete assessment; actual peak may not have been observed. Deployment dates listed in Table 1.

**Statistic reflective of potential impact of long-term vegetation exposure; see text.

***Several days of the monitoring period at Dark Canyon were heavily impacted by a nearby wildfire, see text. Values in this table exclude data from the time during which the fire was active.

III. Discussion:

Monitoring in 2019 marked a return to the lower ozone impacts that have been observed over most of the past decade. Unlike 2018, wildfires did not significantly impact surface ozone at any site, and the most severe impacts were restricted to sites subject to precursor transport from large urban areas.

Ozone at sites in areas already identified by USEPA as being in nonattainment or marginal nonattainment remained at or above levels hazardous to sensitive vegetation and respiratory-challenged humans. These sites are proximate to the Front Range (Goliath Peak, Kenosha Pass) and Wasatch (Snowbird) conurbations, and also on the periphery of oil and gas development in the Uintah Valley of northeastern Utah (Dinosaur CASTNet, Little Mountain).

An exception seems to be the site at Deadman Lookout, about 130 km northwest of Denver. This high-elevation site is remote from urban-source pollution and experiences zonal wind patterns much of the time, factors which ordinarily would keep the site well-mixed and prevent surface ozone impacts. RMRS have no data to formulate working hypotheses regarding the unexpectedly high ozone observations at this site. One highly speculative possibility is that the topography west of the site (Rawah peaks, Laramie River Valley) induces frequent vertical motion in the atmosphere, which might bring stratospheric ozone down to the surface. Anecdotal support for this idea includes turbulence frequently reported by private pilots flying over the area.

Nearly all of the high-elevation sites in eastern and central Colorado experienced a period of elevated ozone in late May into early June, with several sites recording maxima and fourth-maxima during this period. An earlier, short-lived peak occurred a several sites in mid-April, likely as the result of typical springtime vertical motion in the atmosphere. The May-June event was noted a lower elevation sites, but was overshadowed by elevated ozone in mid-August which produced the year's highest numbers at sites on the Pawnee National Grassland.

Farther west, somewhat different patterns prevailed. The May-June period of elevated ozone was detected at some sites but was not as emphatic as the observations on the eastern half of the network. Regionally-synchronous events were largely absent at Region 4 sites.

Two Region 4 sites exhibited unusual patterns in 2019. At Dark Canyon, within the Bear's Ears National Monument, an extreme ozone event occurred in August when two significant wildfires burned to within 10 km of the monitoring site. If regulatory monitoring were occurring at the site, observations during the wildfire would have been discarded under EPA's provisions for extraordinary natural events. The fires served as a reminder of the substantial impacts of wildfires on surface ozone during 2018.

Farther north, at Dinosaur National Monument's CASTNet station, late winter ozone reached an eight-hour average over 80 ppb. This event was driven by the topographical and meteorological conditions characteristic of the Uintah Valley (and similar places like Wyoming's Jonah Basin), which tend to trap emissions from urban sources and oil and gas activity near the surface.

Sites on the western edge of the network (Dark Canyon, Ruby Guard in northeastern Nevada, and Great Basin National Park) remain the least-impacted sites during years of little wildfire activity.

Site	2017	2018	2019	3-Year Average
Pawnee Buttes	63.6	68.8	66.7	66.4
Briggsdale	64.1	70.3	72.8	69.1
Kenosha Pass	66.4	81.9	69.2	72.5
Sunlight Mtn	63.9	74.6	69.9	69.5
Little Mtn	67.9	74.6	71.6	71.4
Shamrock	66.3	71.7	59.6	65.9
Centennial CASTNet	66.8	70.0	65.0	67.3
RMNP CASTNet	67.1	74.1	65.6	68.9
Gothic CASTNet	65.6	69.3	66.4	67.1
GBNP CASTNet	65.1	71.1	66.5	67.6
Mesa Verde CASTNet	66.5	72.1	65.1	67.9
Dinosaur CASTNet	74.4	67.8	70.8	71.0
Deadman Pass	71.6	75.0	63.6	70.1
Goliath Pk	67.7	84.0	69.7	73.8
Trout Cr Pass	46.1	72.6	65.9	61.5
Kremmling	57.1	67.3	60.8	61.7
McClure Pass	62.3	71.6	67.2	67.0
Ripple Cr Pass	67.9	72.1	55.4	65.1
Grand Mesa	65.5	67.3	65.5	66.1
Norwood	61.7	67.5	63.2	64.1
Douglas Pass	65.0	71.9	63.4	66.8
Snowbird	72.4	81.4	69.3	74.4
Dark Canyon	61.5	72.4	57.5	63.8
Ruby Guard	61.1	69.5	60.4	63.7

Table 3. Fourth-maximum daily values and three-year averages, 2017-2019. Red type indicates exceedance of EPA 70-ppb design value.

IV. Funding.

Funds for this work are provided by Regions 2 and 4, USFS; the Ashley and Arapaho-Roosevelt NFs, and RMRS. A summary of funding is provided in Table 4 below:

Source	Jobcode	Allocated, FY19	Expended	Balance, end FY19
Region 2	NFMG16	$30000	$28657	$1343
ARNF	NFVW10	5000	3592	1408
RMRS	FRRESA	10777	10777	0
Total		$45777	$43026	$2751

Table 4. Funding sources, expenditures and remaining balance, ozone data collection and analysis, FY19

The line for RMRS incorporates three pay periods of salary, an approximation of time needed to complete data QC and analyses.

Item	Amount	Percentage of Total
Salary	$32332	75%
Travel	3447	8
Vehicle Mileage	1973	5
Parts/Equipment	3230	8
Contract Repairs	245	1
Contract Services	1800	4

Table 5. Expense categories and percentage of total expenditures

V. Acknowledgments:

RMRS personnel are grateful for the assistance of site operators Brian Murdock (Manti-LaSal NF), Helen Kempenich (retiree volunteer), Chris Plunkett, Kevin Faucher, and Ryan Buerkle (Ashley NF), and Andrea Holland (retiree volunteer). Their efforts result in increased efficiency of this project and considerable cost savings. RMRS also thanks Greg Harshfield, Clyde Sharp, and Bret Harkwell, Air Quality Division, CDPHE, for their efforts to conduct audits at many of the RMRS sites.

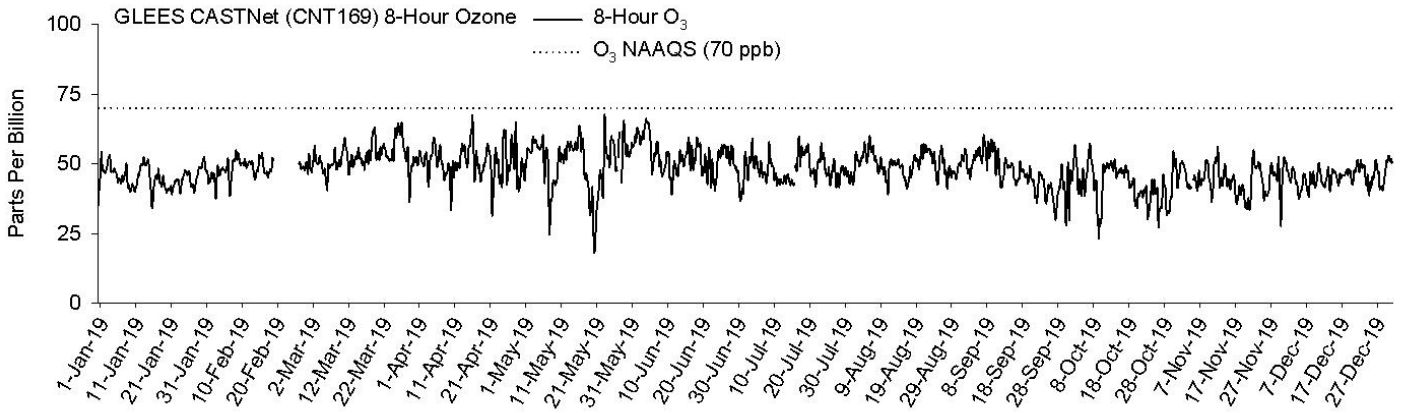
VI. Literature Cited:

Federal Register. 2020. Review of the Ozone National Ambient Air Quality Standards. 85 FR 49830-49917.

Appendix A. Individual Site Data and Discussion.

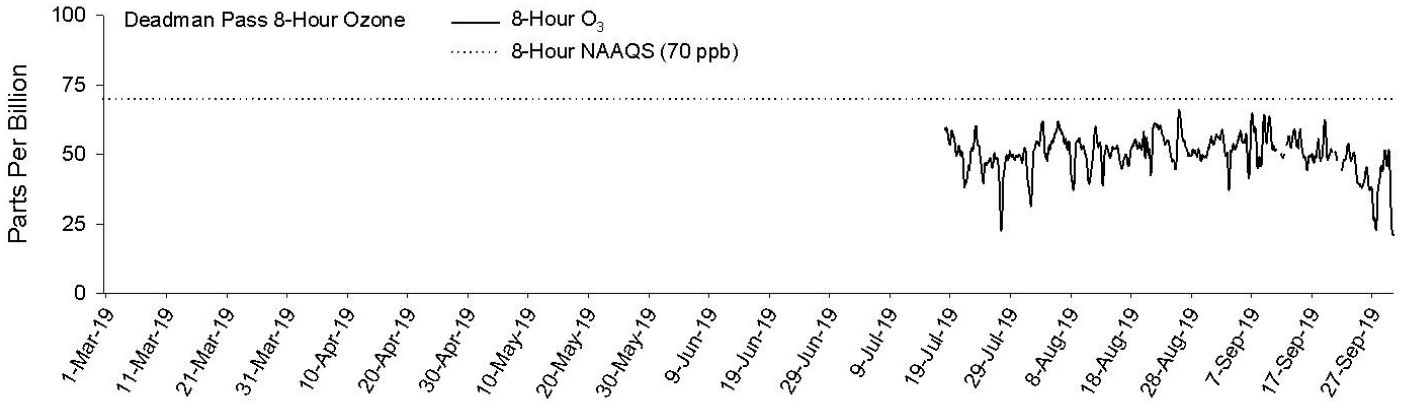
Region 2 Sites.

1. Centennial. Ozone observed at the Centennial CASTNet (CNT169) at the Glacier Lakes Ecosystem Experiments Site in southeastern Wyoming did not exceed the NAAQS in 2019. The only extended period of elevated ozone occurred in late May, when readings frequently exceeded 60 ppb. Ozone exposure was benign otherwise and similar to the pattern seen in most previous years.



The running three-year average of fourth-maxima, at 67.3 ppb, is below the EPA design value. Peak W126, at 10.1 ppm-hr, is similarly below hazard levels.

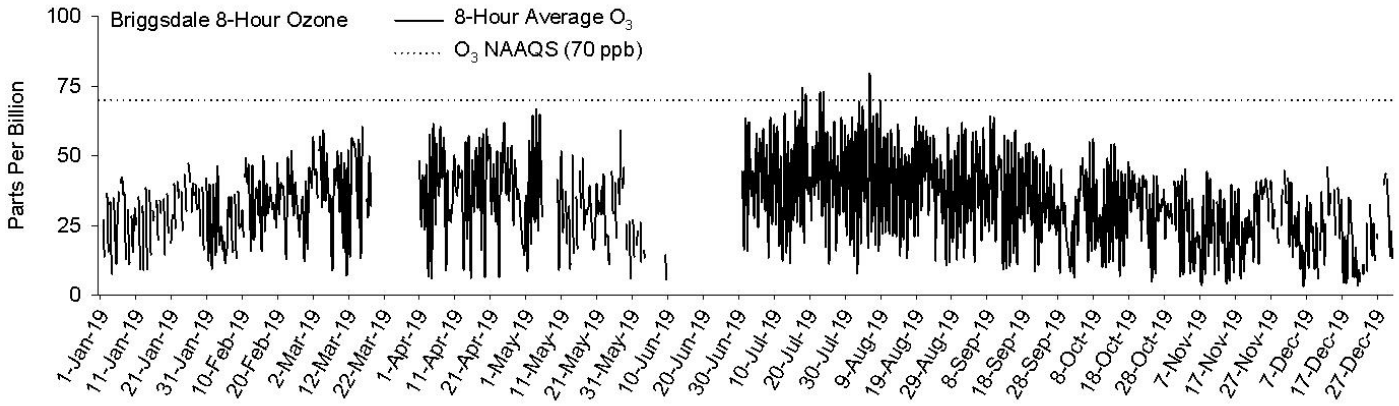
2. Deadman Pass. Deep snow at the site and scheduling conflicts at RMRS prevented an on-time installation at Deadman this year. The data that were captured, from mid-July through September, are not indicative of excess ozone exposure in 2019. However, peak ozone at high-elevation sites such as Deadman usually occurs earlier in the year, and probably was not observed.



This year's fourth-maximum 8-hour value, 63.6 ppb, did not prevent the site's design value (3-year average of 70.1 ppb) from exceeding the NAAQS. Data were not sufficient to calculate a W126 value.

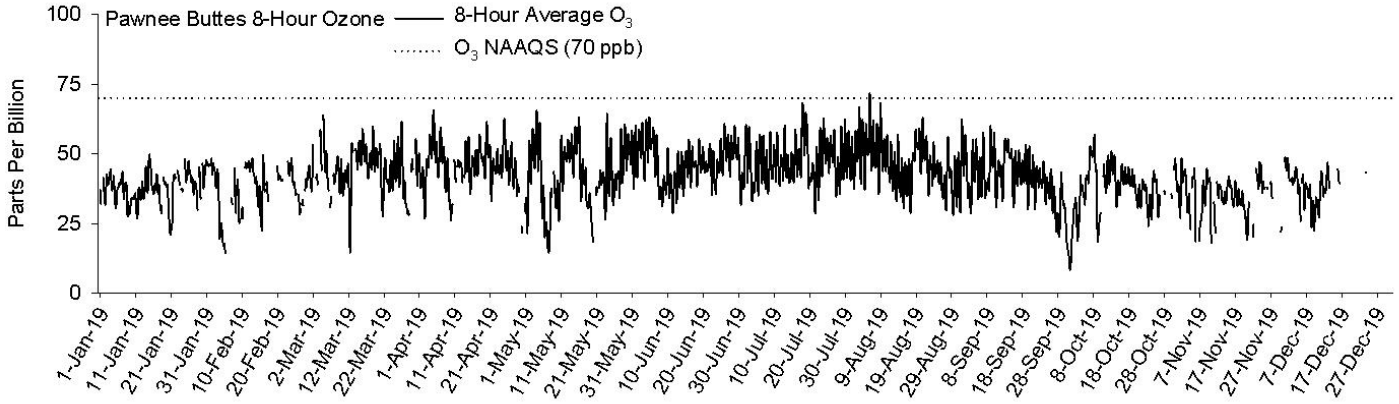
3. Briggsdale. Instrumentation and power supply problems plagued this site in the first half of 2019, unfortunately resulting in some of the most critical late-spring data being lost. Ambient ozone peaked at Briggsdale in late July and early August, with eight-hour averages exceeding 75 ppb. The fourth-maximum value this year was 72.8 ppb, recorded on 23 July during the first of three 70+ ppb exposure events. The site experienced another, less-severe event in early

May.



The data loss prevented a full assessment of exposure at the site, but the W126 metric calculated for the July-September period was 13.7 ppm-hr. The site's design value for 2017-2019 remains below the NAAQS at 69.1 ppb.

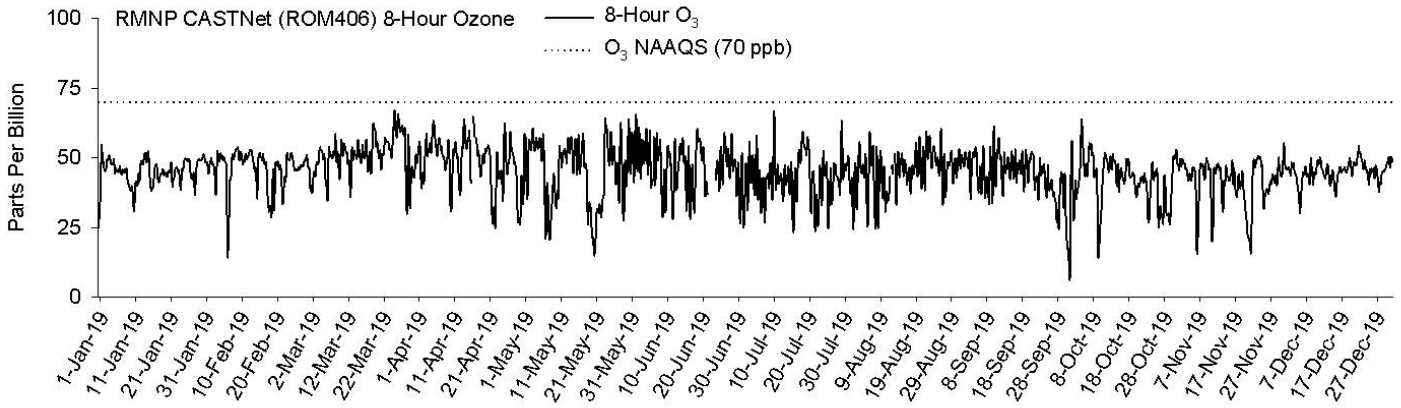
4. Pawnee Buttes. Like Briggsdale, the Pawnee Buttes site is located on the Pawnee National Grassland. This site continues to mirror patterns observed at Briggsdale, but with a slightly lower amplitude. High ozone levels were also observed here from mid-July to early August, with the highest eight-hour readings recorded on 6 August, at 71.9 ppb. The fourth maximum (3 August) was 66.7 ppb.



No major ozone events occurred during the spring. The highest exposure metric was calculated for June-August (11.1 ppm-hr). The 2017-2019 design value remains below the NAAQS at 66.4 ppb.

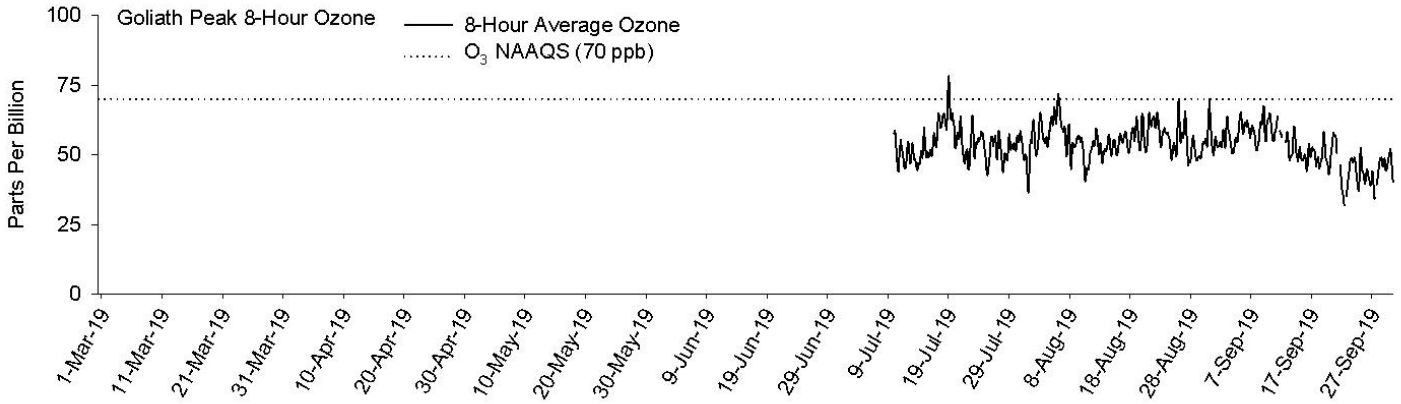
5. RMNP CASTNet. With an open upslope fetch to the Denver metropolitan area, this site has historically been among the network's most impacted. However, ambient ozone was relatively benign here in 2019. Remarkably, the year-round daytime average (47.3 ppb) was 6.5 ppb lower than 2018's average. No significant extended periods of high ozone occurred at this CASTNet site in 2019. Peak eight-hour ozone was observed on 25 March (67.0 ppb), with the fourth

maximum observed on 1 June at 65.6 ppb.



The 2016-2018 design value at RMNP exceeded the NAAQS, but the current value (68.9 ppb) is below the NAAQS for 2017-2019. Peak W126, which has been as high as 27.6 ppm-hr (2012), was only 9.5 ppm-hr in 2019. This makes 2019 the least-impacted year since at least 2006.

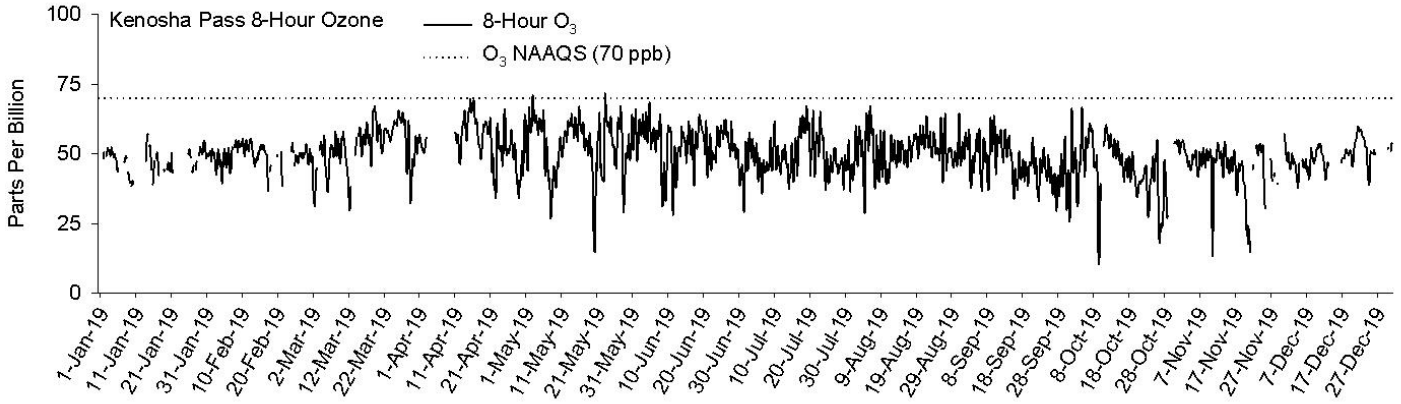
6. Goliath Peak. As at Deadman, access and scheduling difficulties prevented a full collection season. Peak ozone was observed on 19 July (78.3 ppb), with the fourth-maximum eight-hour datum recorded on 28 August (69.7 ppb). A number of brief ozone events approached or exceeded 70 ppb, but no event was long-lived. The daytime average reading, 53.6 ppb, is the highest among all network sites.



The exposure metric W126 was calculated at 11.3 ppm-hr for the July-September period, but the highest ozone exposure was likely not observed. At 73.8 ppb, the three-year design value is still well above the NAAQS. Although the W126 value indicates that hazardous levels of ozone may not have occurred at the site, the three-year average would put the site in nonattainment if the data met EPA collection standards.

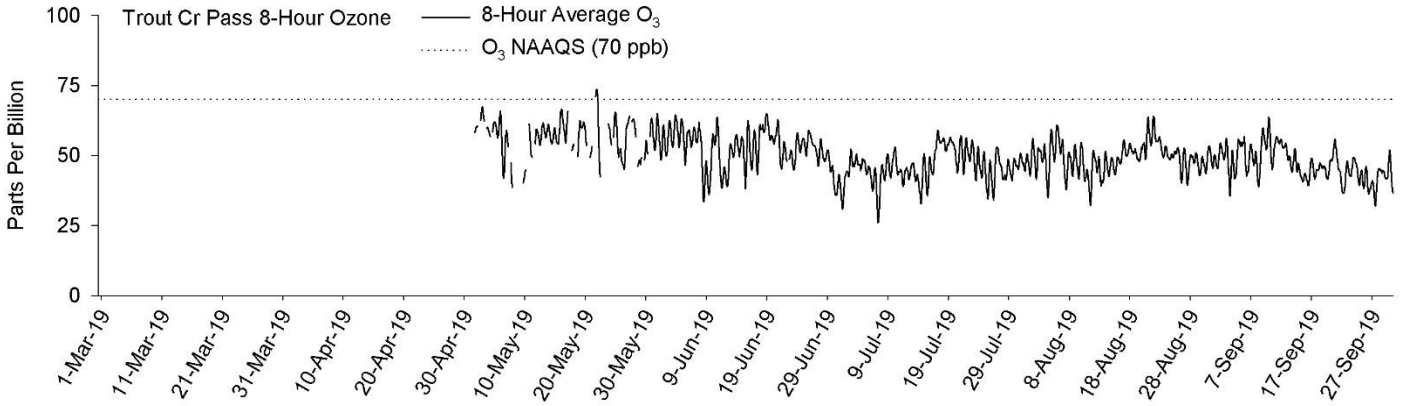
7. Kenosha Pass. Ozone observations followed the usual pattern at Kenosha Pass for most of 2019, with several high-ozone event occurring in mid-springtime. None of these were "extreme" exposure events, but some extended periods of readings of 60 ppb were seen, and the events produced the site's highest (71.7 ppb, 23 May) and fourth-maximum eight-hour (69.2 ppb, 16 April) readings. Unusually, some 60+ ppb readings were recorded in early October; this event

was detectable at other Front Range sites, but the magnitude was greater at Kenosha.



Long-term exposure at Kenosha remains high, with the peak three-month W126 (April-June) at 16.1 ppm-hr. This is the network's highest exposure metric for 2019. Despite the lower fourth-maximum value for this year (vs. 81.9 ppb in 2018), the 2017-2019 design value remains above the NAAQS at 72.5 ppb.

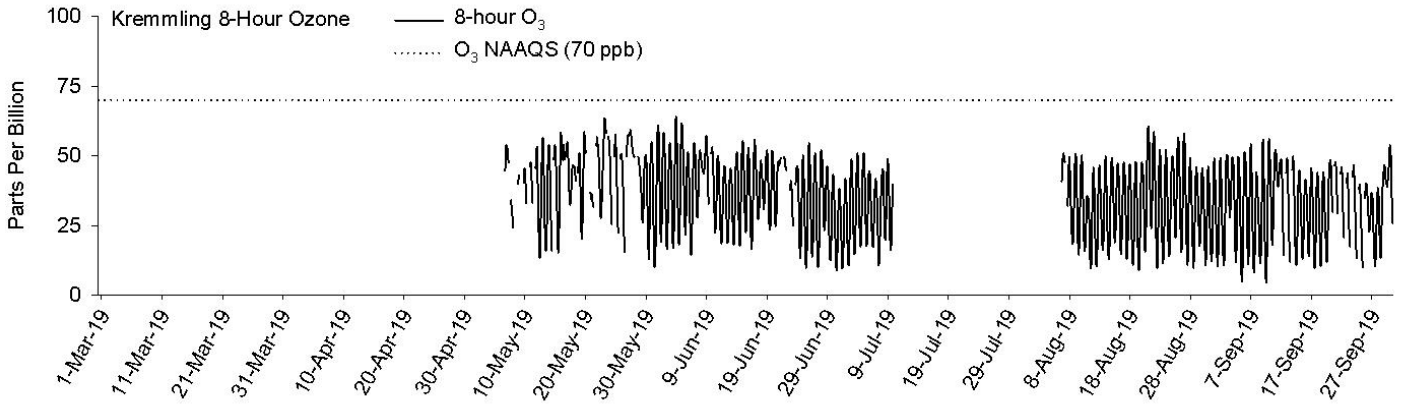
8. Trout Creek Pass. 2019 marked a return to the historically lower-impact ozone characteristics at Trout Creek Pass. Eight-hour fourth maxima exceeded 70 ppb in 2016 and 2018, but did not (65.9 ppb, 6 May) in 2019. One brief event in late May recorded eight-hour means above 70 ppb (peak of 73.6 on 22 May) but surface ozone was otherwise within the range of lower values customarily observed at this well-mixed, relatively remote site.



At 13.4 ppm-hr (May-July), the three-month W126 exposure metric was higher than typical for the site, but not excessively so. The 3-year ozone design value of 61.5 ppb, well below the NAAQS, places the site among the least-impacted on the network.

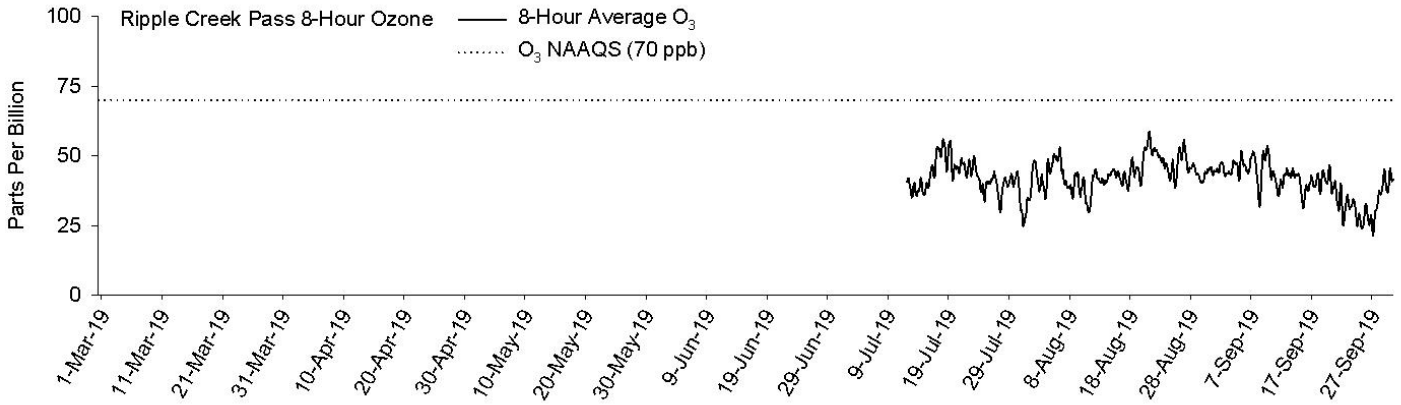
9. Kremmling. The instrumentation enclosure at Kremmling is attached to the fence of the BLM resource area's fleet lot. A windstorm in July knocked the enclosure off, and unfortunately this was not discovered until a site visit by RMRS in early August. About one month of data was lost. However, data coverage was adequate in the springtime, a period that usually includes the year's peak ozone concentrations. No significant ozone exposure events occurred during the period of data collection at Kremmling in 2019. Peak eight-hour concentrations were observed in early June, with maximum

(64.1 ppb) and fourth-maximum (60.8 ppb) values recorded.



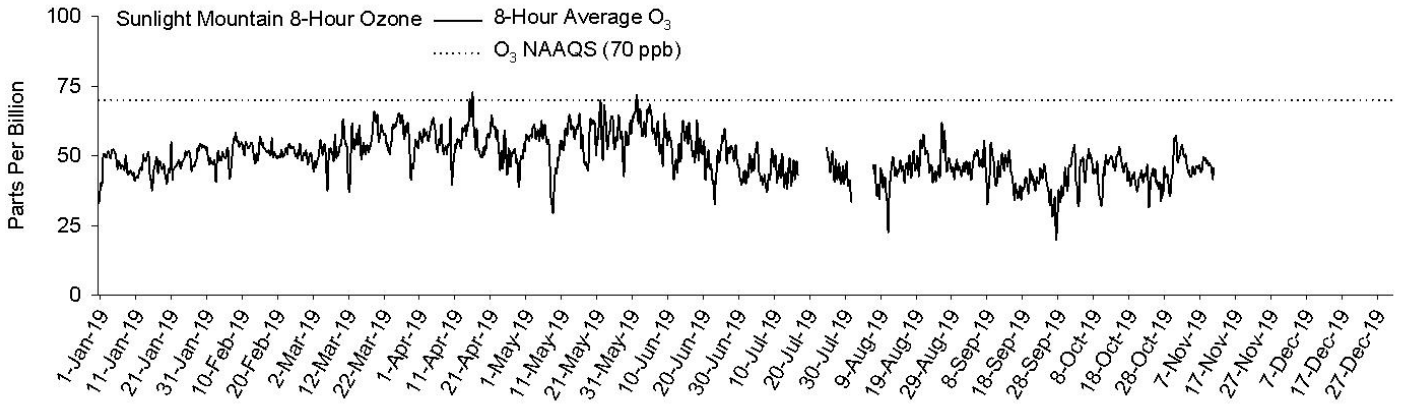
Near the Eagle's Nest and Flattops Wildernesses, Kremmling site ranks among the least-impacted on the network. The three-year design value of 61.7 ppb (2017-2019) is second lowest in this report. Due to the data gap in July, no exposure metric could be calculated for Kremmling this year, but the pattern of available data suggests that no ozone hazard exists at present.

10. Ripple Creek Pass. Early-season data were not available at this year. Historically, this site, adjacent to the Flat Tops Wilderness on the White River NF, has had low to very low ozone impact. The data available this year indicate no departure from this trend. No significant ozone events were noted, and the highest eight-hour average did not exceed 60 ppb.



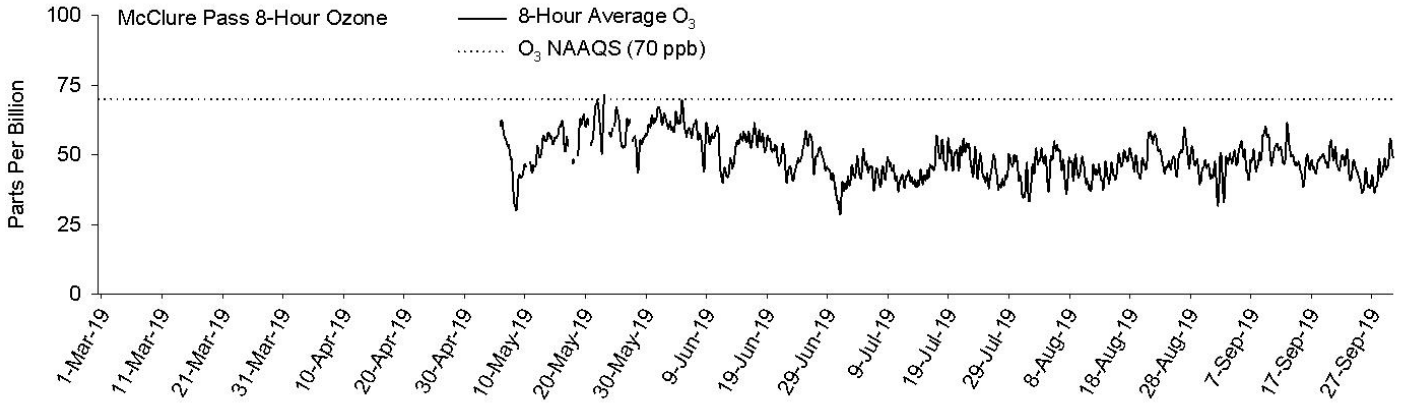
Well-mixed and remote, the site has experienced little ozone impact. The W126 calculated for July-September, the only period for which sufficient data exist this year, was only 2.6 ppm-hr. The 2017-2019 design value, at 65.1 ppb, remains well below the NAAQS.

11. Sunlight Mountain. The equipment at Sunlight was relocated briefly in mid-summer due to the replacement of the comms shelter at the site. Wiring issues at the new shelter also resulted in late-year data loss. However, the interruptions in data collection did not substantially affect viability. Three significant periods of elevated ozone occurred at Sunlight in 2019: one in mid-April (peak eight-hour reading, 72.8), one in late May (fourth-maximum, 69.9 ppb) and a third event (second-maximum, 71.7 ppb) in early June. The April event exhibited hourly-average ozone readings over 60 ppb for 48 hours, and the early-June event persisted at this level for 64 hours. Both of these events produced exposure potentially hazardous to vegetation.



Sunlight's peak W126 was measured in the April-June period, coinciding with the events described above, at 14.0 ppm-hr. At 69.5 ppb, the 2017-2019 design value remains below the NAAQS, but indicates a decline in conditions (2016-2018 DV of 68.7 ppb).

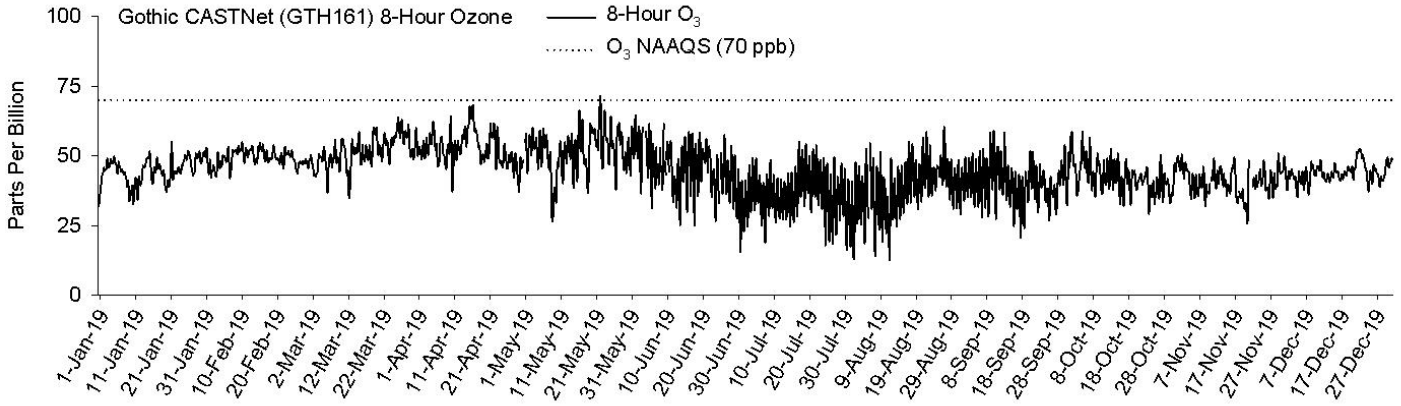
12. McClure Pass. The late-May and early-June events that affected Sunlight were also in evidence in the data from McClure Pass, about 70 km south of Sunlight and adjacent to the Raggeds and Maroon Bells-Snowmass Wildernesses. The year's peak and fourth-maximum eight-hour averages were observed during the May event (71.4 and 67.2 ppb, respectively). Neither elevated-ozone event persisted as long as at Sunlight.



In contrast to the wildfire-affected season of 2018, the data at McClure indicate no significant surface ozone impacts in 2019. Peak W126, at 10.0 ppm-hr (May-July) is below hazard thresholds. The three-year design value of 67.0 ppb is also below the NAAQS.

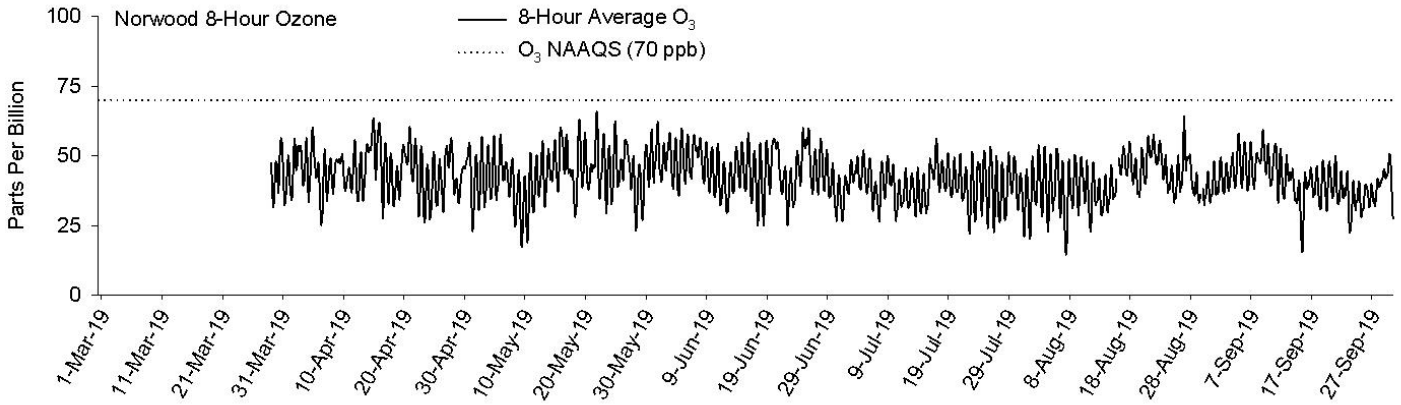
13. Gothic CASTNet. The early-June period of elevated ozone observed at McClure Pass and Sunlight was mostly absent at Gothic, but the April and late-May events were detected. Peak ozone occurred during the May event (71.4 ppb) with the fourth-maximum (66.4 ppb) occurring a few days earlier. Neither event resulted in extended periods of exposure.

Ozone observations during the remainder of the year remained at the benign concentrations typical of the site.



At 66.4 ppb, the 2017-2019 design value at Gothic is below the NAAQS and consistent with the remote character of the site. Highest three-month W126 was 12.7 ppm-hr during the March-May period. The three-year design value of 67.1 meets the ozone NAAQS.

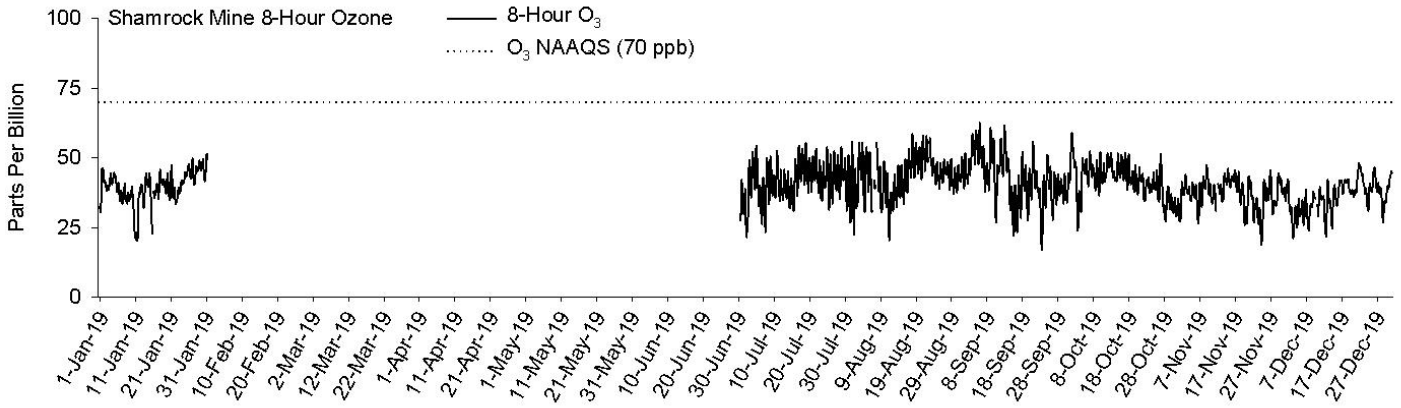
14. Norwood. Since the inception of monitoring at Norwood in 2011, eight-hour average ozone has exceeded 70 ppb on only a handful of occasions, and 2019 did not add to that total. Eight-hour average ozone never exceeded 65.9 ppb in 2019, a value observed on 22 May. The fourth-maximum of 63.2 was observed on the 19th of the same month. No periods of significantly elevated ozone occurred at Norwood. As at Kremmling, the urban setting of the site resulted in low values for ozone during hours of darkness due to ozone titration.



Norwood remains one of the least-impacted sites, with few precursor sources located nearby or upwind. The three-year design value of 64.1 ppb is well under the NAAQS, and peak long-term exposure (W126 of 9.2 ppm-hr, April-June) indicates no ozone hazard was present in 2019.

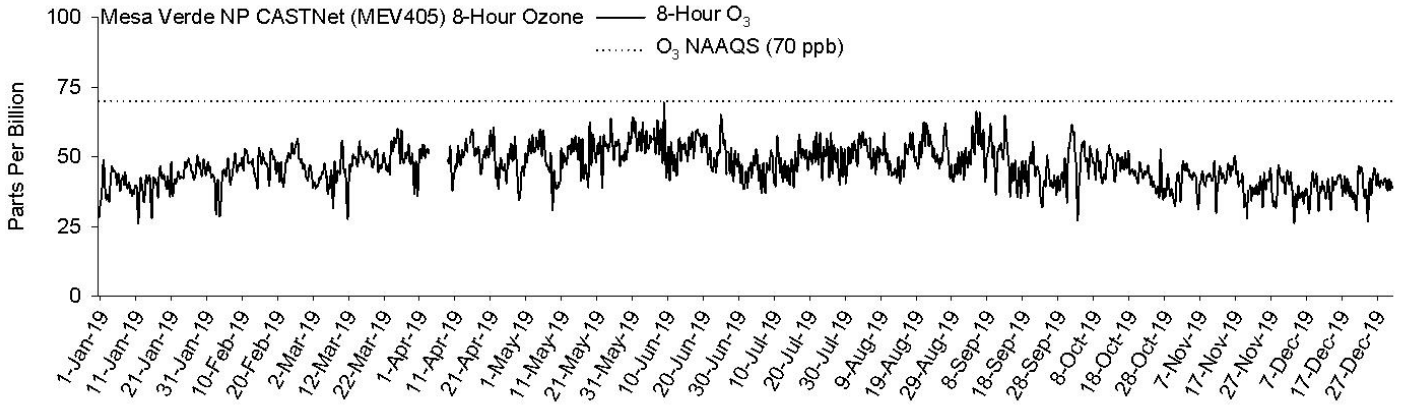
15. Shamrock. This site is funded jointly by the USFS and BLM and maintained under a contract to Air Resource Specialists. Budgetary issues at BLM resulted in a lapse of funding from January to July of 2019. Peak ozone levels probably occurred during this time; nearby sites Norwood and Mesa Verde both recorded springtime maxima. No periods of elevated ozone occurred during that part of 2019 that was observed, with the highest observation of 62.6 ppb

recorded on 6 September. The fourth maximum was only 59.6 which occurred one day earlier.



No significant ozone exposure impacts occurred during the period of monitoring, nor did any occur at surrounding sites. The July-September W126 value of 6.2 ppm-hr was the highest noted with available data.

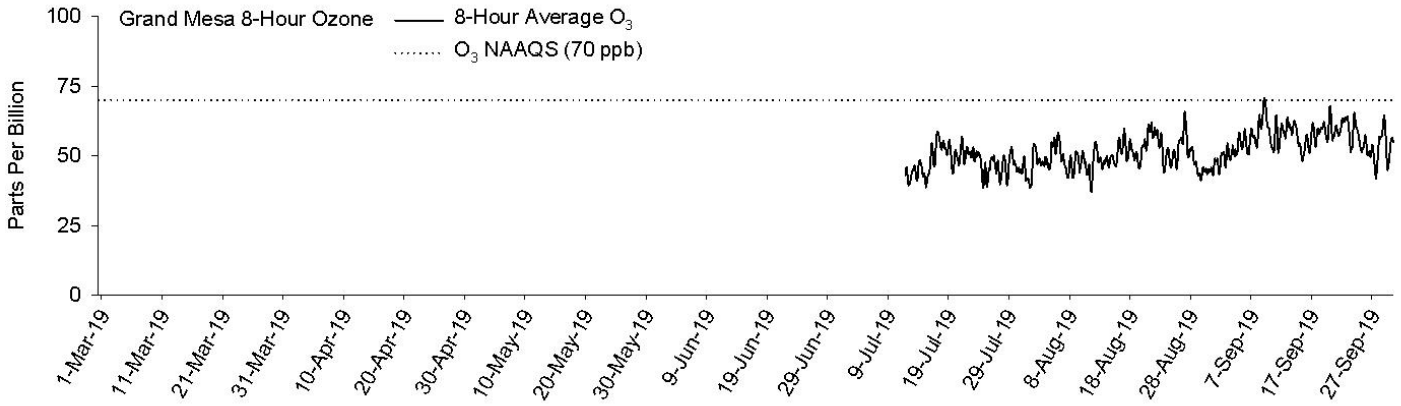
16. Mesa Verde National Park CASTNet. Like Norwood, this site is remote from precursor sources and typically experiences low ambient ozone. The eight-hour average hit 69.5 ppb on 9 June, the year's highest, and the fourth maximum of 65.1 ppb was recorded on 25 June. No extended periods of elevated ozone occurred.



Longer-term exposure was low, with the peak W126 measurement of 10.5 ppm-hr occurring in the April-June three month period. Although the fourth maximum ozone exceeded the NAAQS in 2018, the average for 2017-2019 remains below the NAAQS at 67.9 ppb. No ozone hazard is current present at Mesa Verde.

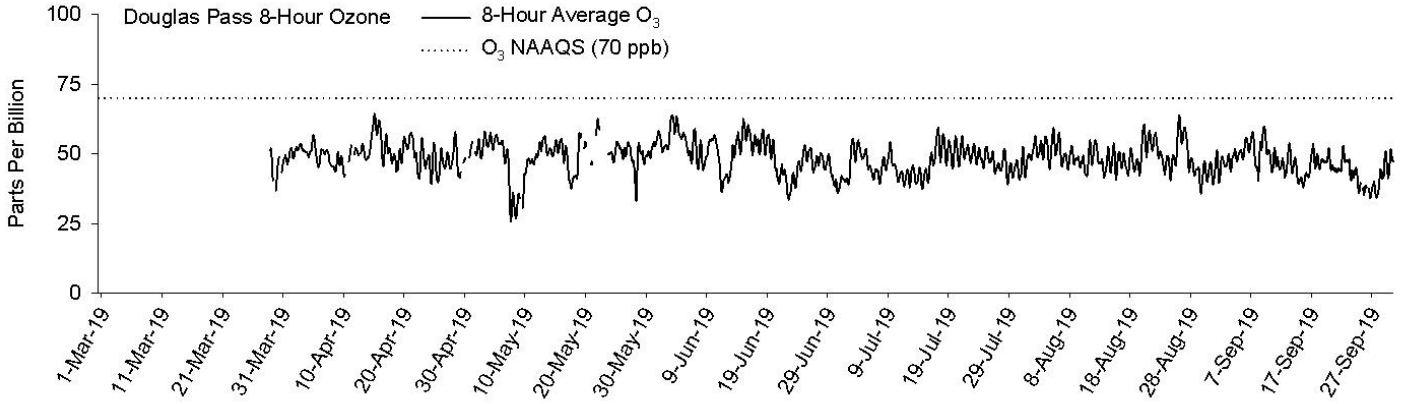
17. Grand Mesa. 2019's highest recorded ozone concentrations at Grand Mesa were recorded in September during a brief period of elevated ozone. An eight-hour average of 70.9 ppb occurred on 9 September, and 24 September saw the fourth maximum of 65.5 ppb. Unfortunately, no early season data were recorded at the site, and the actual ozone peak

for the year likely was not observed.



Despite some higher-than-usual readings in recent years, Grand Mesa has not yet approached the NAAQS design value. The current 2017-2019 average stands at 66.1 ppb. The only three-month W126 for which sufficient data existed in 2019, for July-September, was 9.2 ppm-hr.

18. Douglas Pass. This site experienced a substantial drop (6.5 ppb average for the season) from the wildfire-influenced observations of 2018. Peak and fourth maximum eight-hour values were 64.4 (13 April) and 63.4 (4 June) ppb, respectively. No significant periods of elevated ozone occurred at this site in 2019.

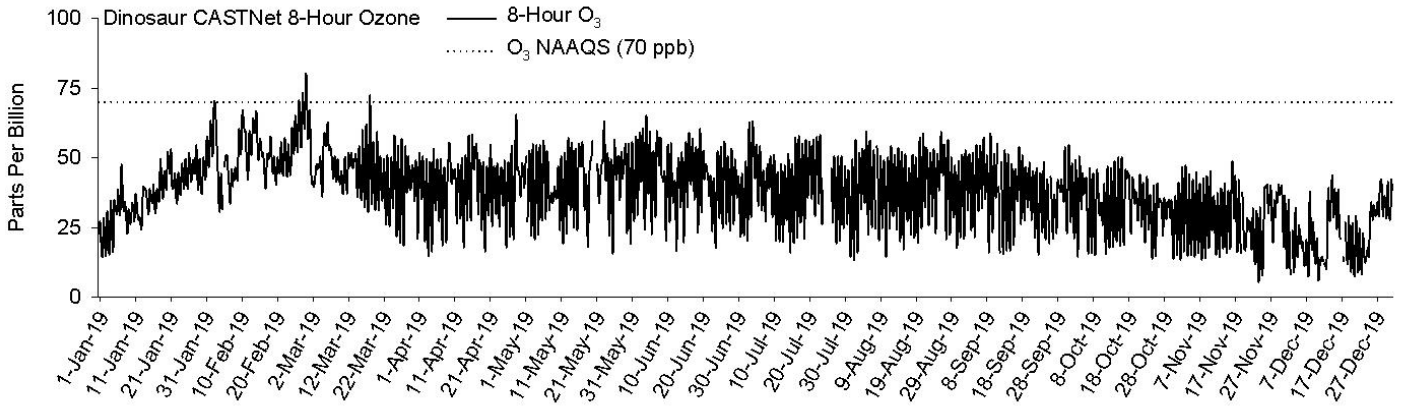


Peak W126, at 7.6 ppm-hr (April-June) was second-lowest on the network among sites that could be adequately assessed. Design value (66.8 ppb for 2017-2019) remains below NAAQS, and no ozone hazard is current present.

Region 4 Sites.

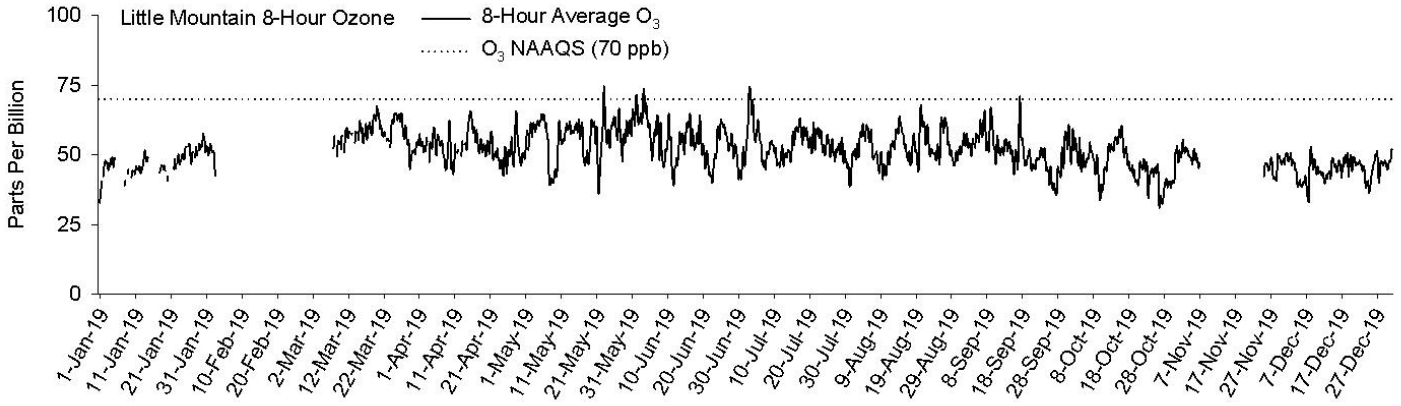
19. Dinosaur National Monument CASTNet. Adjacent to the pollution-plagued Uintah Basin, the Dinosaur CASTNet site has resumed its place as one of the network's more heavily-impacted locations. Unlike many other sites, peak ozone may occur here during the winter months as inversions, sunshine and snow cover combine to produce high near-surface concentrations. A late-February event produced this year's highest numbers, 80.4 and 70.8 ppb (peak and fourth

maximum, respectively). Ozone averaged 65.5 ppb for an 82-hour period during the event.



Portions of this part of Utah remain in "marginal nonattainment" status subsequent to their designation by the EPA in 2018, and the fourth maximum figure for 2019 did not indicate significant improvement. At 71.0 ppb, the three-year average exceeds the NAAQS. Fortunately, exposure as quantified by peak three-month W126, at 9.6 ppm-hr (February-April), is down from recent those of recent years. The occurrence of peak ozone so early in the year, before most vegetation begins photosynthesis, helps mitigate the impact of high surface ozone.

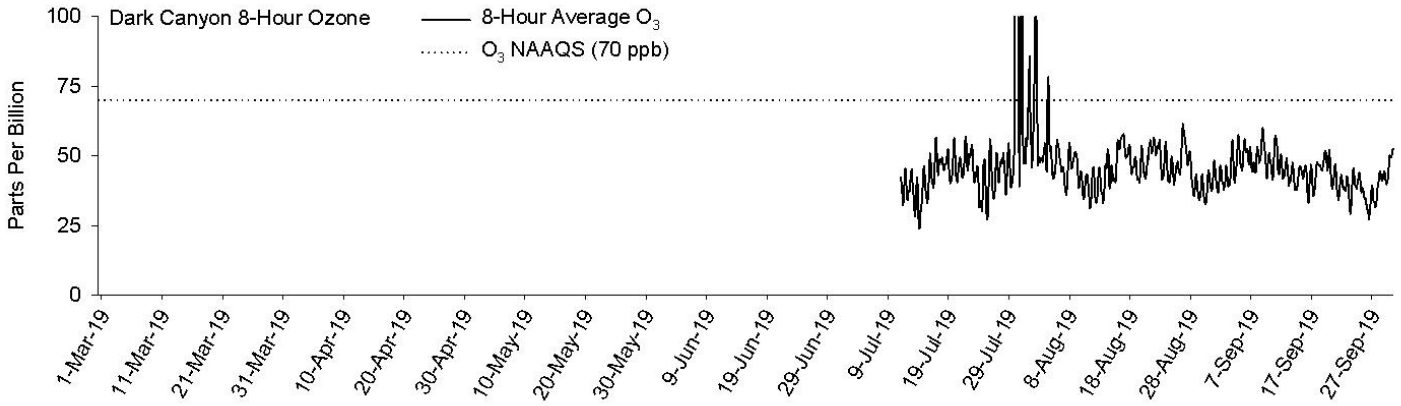
20. Little Mountain. This year, and 2018, are a distinct break from patterns of ozone observations at this site, located west of Vernal, Utah, at about 2620 m. Brief periods of elevated ozone occurred in May (peak eight-hour average of 74.6 ppb), early July and mid-September, and a more significant event in early June produced the fourth maximum reading of 71.6 ppb. The early-June event, 145 hours in length, produced an average of 64.5 ppb.



The consistently higher observations of the last two years have put Little Mountain over the NAAQS design value threshold, at 71.4 ppb for 2017-2019. The site's elevation and location northwest of the area most impacted by oil and gas development has kept it isolated from the most severe air quality effects in years past. However, the pattern of surface ozone seems to have shifted recently. Three-month W126, peaking at 14.6 ppm-hr, is down from 2018's figure but still above numbers seen in the last several years.

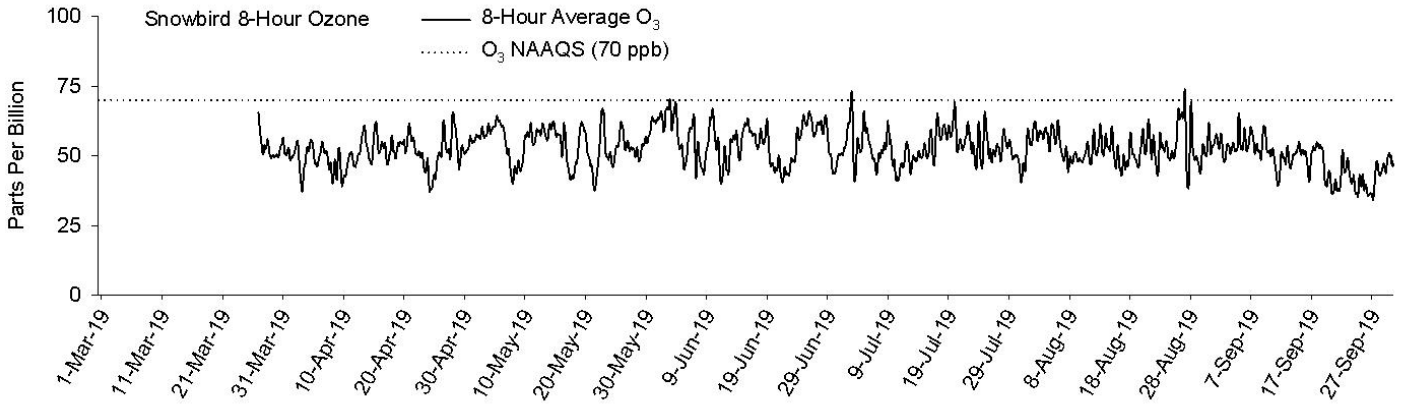
21. Dark Canyon. Like the other Four Corners-area sites, Dark Canyon is distant from precursor sources, and this year's numbers continue the narrative of a site with little air quality impacts. Significant local impacts this year came in the form of wildfire emissions from the Poison Canyon and Peavine Canyon fires, which burned just west of Gooseberry Guard Station, where the monitor is installed. Excluding the week during which the fires were active, the highest eight-

hour readings at the site were recorded on 25 August (60.2 ppb), with the fourth maximum of 57.5 ppb on 5 September.



Peak readings during the fire are unknown, as the instrument is known to be inaccurate when exposed to extremely high smoke concentrations.

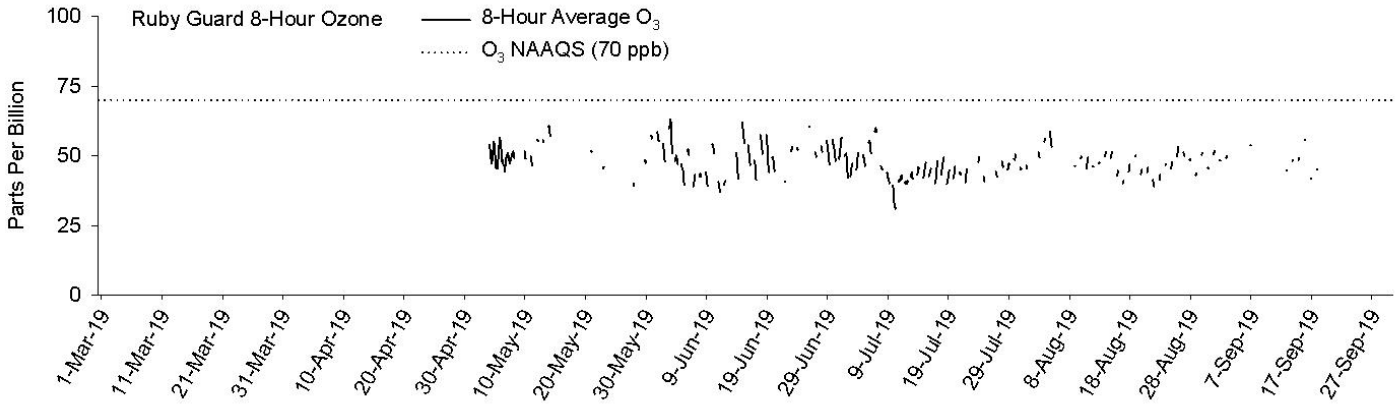
22. Snowbird. Much of the Wasatch Front remains in "marginal nonattainment" by the EPA's 2018 adjudication, and data from the mid-mountain monitoring site at Snowbird Ski Resort indicate that only minor progress has been made. Peak eight-hour average ozone of 74.0 ppb occurred on 27 August during long-duration, late-season event. The 60-hour event averaged 60 ppb. Two other significant events, both in June, were noted. The early June event produced the fourth maximum reading of 69.3 ppb. Several other short-duration events produced eight-hour averages in the high 60s ppb.



Urban-source precursors continue to plague national forests and wilderness areas in the Wasatch Front. The 2017-2019 design value at Snowbird, 74.4 ppb, is down only slightly from the 2016-2018 figure, and three-month exposure (W126 of 15.3 ppm-hr for June-August) is the second highest among all network sites. Ozone remains a potential hazard for vegetation at Snowbird, and also to the area's large human visitorship.

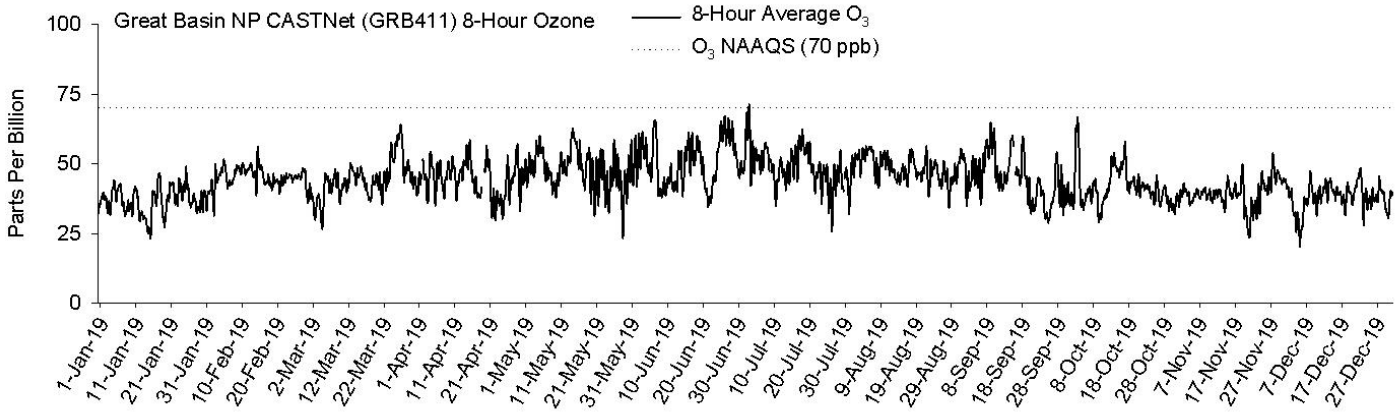
23. Ruby Guard. Across the Great Salt Lake basin from Snowbird and the greater SLC metropolitan area, electrical and datalogger gremlins plagued this site at the eastern foot of the Ruby Mountains. The site's entire suite of equipment was removed at the end of the 2019 season, and improved, four-season equipment will be installed for 2020. Of the incomplete data collected, a peak eight-hour value of 63.2 ppb was seen on 3 June, and a fourth maximum of 60.4 ppb

was recorded on 26 June.



Though incomplete, the data indicate that ambient ozone likely remains below hazard threshold at this site. What little valid data are available from 2019 mirror trends in previous benign years.

24. Great Basin National Park CASTNet. Like Dark Canyon and Ruby Guard, GBNP is distant and isolated from upwind precursor sources. In 2019, wildfire activity was limited and the site experienced a relatively pollution-free year. Eight-hour ozone peaked at 71.4 ppb on 3 July, with the fourth maximum (66.5 ppb) recorded several days earlier. No long-duration periods of elevated ozone occurred in 2019, although several brief events produced readings near 70 ppb.



No current ozone hazard is indicated at GBNP (peak W126 of 10.0 ppm-hr, May-July). The three-year design value currently stands at 67.6 ppb.